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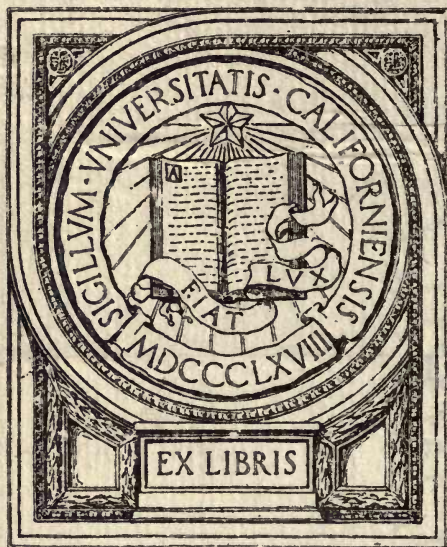
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Minerals separation, limited complaint

IN THE

District Court of the United States,

FOR THE DISTRICT OF DELAWARE.

No. 331.

IN EQUITY.

MINERALS SEPARATION, LIMITED,

Plaintiff,

v.

MIAMI COPPER COMPANY,

Defendant.

Suit on U. S. Patents Nos. 835,120,
692,678 and 1,099,699.

Before

Hon. Edward G. Bradford,
U. S. District Judge.

OPINION OF THE COURT

Filed September 29, 1916.

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Gift of Shendaw, Wilkinson & Scott

UNIV. OF
CALIFORNIA

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The bill in this suit was brought by the Minerals Separation, Limited, a corporation of Great Britain, against the Miami Copper Company, a corporation of Delaware, charging infringement of three United States process patents relating to ore concentration, owned by the plaintiff, namely, No. 835,120, of November 6, 1906, to H. L. Sulman, H. F. Kirkpatrick-Picard and J. Ballot, No. 962,678, of June 28, 1910, to H. L. Sulman, H. H. Greenway and A. H. Higgins, and No. 1,099,699, of June 9, 1914, to H. H. Greenway, assignor to the plaintiff.

Under the processes shown in the three patents a signal advance has been made in the art of ore concentration in point of simplicity, economy and efficiency, and in their practice large commercial success has been realized. Ore concentration in metallurgical operations is the separation of the metalliferous or metallic part of the ore from the non-metallic and worthless material, known as gangue, found associ-

ated with it in nature, in order that the valuable mineral or metallic particles may be in proper condition for the subsequent process of smelting. The ores to which the process of the patents in suit are applicable are mainly chemical compounds of metal and sulphur, copper sulphides, zinc sulphides, or lead sulphides. Prior to the invention or rather discovery covered by the first patent in suit ore concentration had assumed a number of forms differing from one another in the principle of their operation, but all of them requiring, as do the processes now practiced, as an essential condition of the separation of the mineral from the gangue, the crushing or grinding of the ore into particles of such a degree of fineness as to produce useful results. The ore having been so crushed or ground was subjected to treatment to secure the desired concentration; such treatment varying, according to the particular process employed. In what was known as water or gravity concentration the ore was mixed with water forming the ore pulp, and through shaking or agitation of the pulp by well-known devices the metallic particles, becoming separated from the particles of gangue and having greater specific gravity than the water, sank to the bottom, while the particles of gangue, having less specific gravity than the mineral particles, although greater than that of the water, were subjected to an up-current, not strong enough to prevent the metallic particles from sinking, but strong enough to carry the particles of gangue to the surface where they would escape over the edge of the containing vessel or be otherwise disposed of. Such processes, however, were far from commercially successful, being wasteful of water, of power and of a considerable proportion of the metallic particles in the slimes which were carried by the up-current to the surface and were lost with the gangue. Without pausing at this point to consider other processes of

ore concentration disclosed in the prior art, hereinafter discussed, an important and, indeed, vital difference between water or gravity concentration under such processes as those above referred to, on the one hand, and concentration under the processes of the patents in suit, is that while in the former the metallic particles after being separated from the gangue in the ore pulp sank to the bottom, in the latter the metallic particles coated with an extremely thin film of oil, become attached to air-bubbles in the ore pulp, and the bubbles with the attached metallic particles rise to the surface, forming a mineral froth of such coherency and permanency as to afford full opportunity for its removal from the surface for further treatment of the metallic particles. The ore pulp in the process of each and every of the three patents in suit consists of a mixture of water and crushed or pulverized mineral ore, together with one or more other ingredients. In each the agitation of the pulp coupled with the introduction of air into it develops and distributes throughout the mixture small bubbles of air which attach themselves to the metallic particles, to the exclusion of gangue, and rise with them and form a metallic air froth on the surface, readily removable therefrom, the gangue particles sinking to the bottom and being disposed of as refuse.

In the description of the first patent in suit, No. 835,120, for "Improvements in Ore Concentration" it is stated:

"This invention relates to improvements in the concentration of ores, the object being to separate metalliferous matter, graphite, and the like from gangue by means of oils, fatty acids, or other substances which have a preferential affinity for metalliferous matter over gangue. In the process described in the previous United States patent, No. 777,273, granted to A. E. Cattermole, an amount of oil varying from four per cent. to

six per cent. of the weight of metalliferous matter present is agitated with an ore pulp, so as to form granules which can be separated from the gangue. In the previous United States patent, No. 777,274, granted to A. E. Cattermole and others, a similar method of separation is employed, oleic acid being produced *in situ* in the ore pulp.

We have found that if the proportion of oily substance be considerably reduced—say to a fraction of one per cent. on the ore—granulation ceases to take place, and after vigorous agitation there is a tendency for a part of the oil-coated metalliferous matter to rise to the surface of the pulp in the form of a froth or scum. This tendency is dependent on a number of factors. Thus the water in which the oiling is effected is preferably slightly acidified by adding, say, a fraction of one per cent. up to one per cent. of sulfuric acid or other mineral acid or acid salt, the effect of this acidity being to prevent gangue from being coated with oily substance, or, in other words, to render the selective action of the oil more marked; but it is to be understood that the object of using acid in the pulp according to this invention is not to bring about the generation of gas for the purpose of flotation thereby, and the proportion of acid used is insufficient to cause chemical action on the metalliferous minerals present. Again, we have discovered that the tendency for the oily substance to disseminate through the pulp and the rapidity with which the metalliferous matter becomes coated is increased if the pulp is warmed. The formation of froth is assisted by the fine pulverization of the ore, and we find that slime mineral most readily generates scum and rises to the surface, while larger particles have less tendency to be included in the froth. The proportion of mineral which floats in the form of froth varies considerably with different ores and with different oily substances, and before utilizing the facts above mentioned in the concentration of any particular ore a simple preliminary test is necessary to determine which oily

substance yields the proportion of froth or scum desired.

The following is an example of the application of this invention to the concentration of a particular ore. An ore containing ferruginous blende, galena, and gangue consisting of quartz, rhodonite, and garnet is finely powdered and mixed with water containing a fraction of one per cent., or up to one per cent. of a mineral acid or acid salt, conveniently sulfuric acid or mine or other waters containing ferric sulfate. To this is added a very small proportion of oleic acid, (say from 0.02 per cent. to 0.5 per cent. on the weight of ore.) The mixture is warmed, say, to 30° to 40° centigrade and is briskly agitated in a cone mixer or the like, as in the processes previously cited, for about two and one-half to ten minutes, until the oleic acid has been brought into efficient contact with all the mineral particles in the pulp. When agitation is stopped, a large proportion of the mineral present rises to the surface in the form of a froth or scum which has derived its power of flotation mainly from the inclusion of air-bubbles introduced into the mass by the agitation, such bubbles or air-films adhering only to the mineral particles which are coated with oleic acid. The minimum amount of oleic acid which can be used to effect the flotation of the mineral in the form of froth may be under 0.1 per cent. of the ore; but this proportion has been found suitable and economical. If the ore were crushed to ninety mesh to the linear inch, (half of which ore will pass through one hundred and fifty mesh sieve,) the froth may contain about seventy per cent. to eighty per cent. of the metalliferous matter present in the ore. This froth is removed from the pulp by spitzkast, up-cast, skimming, draining, or otherwise. After subsidence the oil-coated metalliferous matter removed as froth is separated from any liquid which may have accompanied it and treated with a dilute solution of caustic alkali; which removes the oleic acid in the form of a solution of soap.

If desired, the oleic acid used in the first instance may be produced *in situ* in the pulp by decomposing a dilute soap solution with mineral acid, as described in the previous patent, No. 777,274, cited above. The oleic acid or other fatty acid forming the coating on the metalliferous matter which produces the froth may give rise to insoluble soaps on the surface of the metalliferous matter, if soluble lime, iron, or other salts are present in small quantity during the production or on the breaking down of the froth with alkali. Such insoluble soaps are difficult to remove and are capable of adhering to air and causing flotation, much the same as the fatty acids do. The metalliferous matter which did not form part of the froth (generally the larger particles) remains in admixture with the gangue in the pulp. To recover this, the pulp is distributed in a thin layer on a shaking-table, convex buddle, or the like, whereon the mineral is exposed to a free-air surface, which exposure may be increased by the application of air-blast or air-jets or the like and thereafter brought onto the edge or surface of liquid, whereby the metalliferous matter floats and is separated from the gangue, which sinks, as described in the specification of our previous United States application Serial No. 246,637, filed February 20, 1905. The proportion of mineral recovered in the froth and that recovered by table flotation may be considerably varied; but, generally speaking, the froth will separate the slime mineral while the larger particles are recovered by the latter method."

The charge of infringement of patent No. 835,120 is restricted to claims 1, 9 and 12, as follows:

"1. The herein-described process of concentrating ores which consists in mixing the powdered ore with water, adding a small proportion of an oily liquid having a preferential affinity for metalliferous matter, (amounting to a fraction of one per cent. on the ore), agitating the mixture until

the oil-coated mineral matter forms into a froth, and separating the froth from the remainder by flotation."

"9. The process of concentrating powdered ores which consists in separating the mineral from the gangue by coating the mineral with oil in water containing a small quantity of oil, agitating the mixture to form a froth, and separating the froth."

"12. The process of concentrating powdered ore which consists in separating the minerals from gangue by coating the minerals with oil in water containing a fraction of one per cent. of oil on the ore, agitating the mixture to cause the oil-coated mineral to form a froth, and separating the froth from the remainder of the mixture."

The first patent in suit is for what is known as an air flotation process, in which, owing to the use of a frothing agent in conjunction with such agitation of the ore pulp as will distribute the metallic particles of the ore throughout the mixture and produce bubbles of air and bring them in contact in the mixture with the metallic particles so distributed, the bubbles will become attached to such metallic particles, carrying them separate from the particles of gangue up through the surface of the mixture where they can readily be collected by skimming, overflow, or the use of other well known devices. In this process the frothing agent consists of an oil or other immiscible substance or material of an oily nature, and the bubbles and metallic particles become attached to each other through affinity between the bubbles and the metallic particles enhanced by the coating of the latter with an extremely thin film of oil. The old water processes of ore concentration were in some features gravely objectionable. Under those processes it was desirable to avoid very fine grinding of the ore as being calculated to cause the fine particles containing metal constituting

the slimes to escape with gangue particles and be lost, such fine metallic particles, as before stated, not sinking so readily and quickly as those which were larger. In those processes there were two things to be avoided; first, the crushing or grinding of the ore to such a degree of fineness as to lead to the loss of metallic particles through their escape with gangue particles, and secondly, too coarse a crushing or grinding whereby particles of ore containing both metal and gangue might, with the gangue preponderating, too readily be carried to the surface and lost with the other gangue particles. The defendant admits in its brief that the air bubbles collect the metallic particles, and the oil or other modifying agent in the mixture gives permanency to the mineral froth; that the attraction of the air bubbles for the metallic sulphide particles leads to the separation of those particles from the gangue; that in the absence of oil or other modifying agent in the pulp, facilitating the formation of air or other gas bubbles, no process of ore concentration employing such bubbles is possible; that air flotation may be brought about (1) by introduction of air at the bottom of the mixture or sub-aeration; (2) by beating air into the mixture or supra-aeration, (3) by generation of gas or liberation of air in the mixture. But there is an accentuated difference of opinion between the parties on the point of preferential affinity of oil for metallic particles as compared with gangue. The defendant in its brief states that "in ore flotation processes the oil or other modifying agent does not have any more attraction for the metallic particles than for the gangue." This position, however, is in conflict with evidence on the part of the defendant, with the evidence on the part of the plaintiff, with the documents of the art, and with the result of the physical demonstrations made by both parties in open court. In the Cattermole process patent No. 777,273,

it is stated that "the oil has a more or less selective action and will coat the particles of metalliferous matter in preference to the particles of gangue, while the particles of gangue will be wetted by the water," and further, that "if the water which is mixed with the oil is acidulated with mineral, fatty or other acid, the selective action of the oil will thereby be rendered more marked and decisive." So the process of the Haynes British patent, No. 488 of 1860, depends wholly upon the adhesion of the oil or fat to the metalliferous matter in preference to the gangue. In the Everson patent No. 348,157 it is said:

"The discovery which forms the basis of my invention is that metals and metallic substances in a comminuted state will unite with compounds of fats or oils and acids, and that such compounds will not unite with comminuted quartz or other rocky gangue."

In the Fryer Hill Publication of October 30, 1889, it is stated that "the whole system of concentration appears to be based on the well known affinity of the lighter forms of sulphuret and chloride of silver for oils." In the Sulman and Picard patent No. 793,808 it is stated that "the present invention relates to the concentration of ores by separation of the metalliferous constituents * * * from the gangue by means of oils, grease, tar, or any similar substance which has a preferential affinity for metalliferous matter over gangue." In the California Journal of Technology of November, 1903, it is stated that "the process depends upon the fact that minerals with a metallic lustre, when treated in the form of a wetted pulp, adhere to oil, while earthy minerals do not." In the Kirby patent No. 838,626 it is said:

"The object of this invention is to effect with substantial completeness the segregation of those pulverized mineral particles which have a pref-

erential adhesion for water from those which have a preferential adhesion for a liquid immiscible in water—for example, oil, or a solution of bitumen in kerosene.”

So, in the Sulman patent No. 835,143 it is said:

“This invention relates to improvements in the concentration of ores, the object being to separate metalliferous matter, graphite, and the like from gangue by means of oils, fatty acids, or other substances which have a preferential affinity for metalliferous matter over gangue.”

The defendant offered no evidence in contradiction of the above statements in patents and other documents, but on the contrary did submit evidence confirming those statements. Dr. Sadtler, one of the defendant's experts, testified:

“Within recent years it has been found necessary to look further than the simple question of the relative selective action of oil for mineral particles, as contrasted with the effect upon the gangue, or the question as to whether the gangue was more readily wetted than the mineral sulphide particles.”

With respect to his statement just quoted he was asked, “Now, as I understand that, you do not mean that you have to discard that selective action of oil for mineral particles, do you?”, to which he replied, “No; I do not mean that.”

One of the principal questions in the case is whether patentable invention was involved in the discovery that the minute proportion of .1% of oil to the ore was sufficient for commercially successful operations in ore concentration. On this question I had some doubt during the presentation of the case. But that doubt has since been removed. Sulman, Picard and Ballot had for more than two years prior to

March, 1905, been interested in conducting ore concentration under what was known as the "Cattermole process," and had been seeking to improve the same in such manner as to render it more efficient and less expensive. There were a number of patents relating to this process, using the term in a general sense, among which were No. 763,259 of June 21, 1904, No. 763,260 of June 21, 1904, and No. 777,273 of December 13, 1904, all to A. E. Cattermole. In the process of each of these patents metalliferous granules are formed and separated from the gangue and fall to the bottom, while the gangue is carried up and away. In No. 777,273 the patentee states:

"The present invention relates to improvements in the separation of the metalliferous constituents of ores and the like from gangue by means of the selective action of oils and certain tar products or similar compounds (all hereinafter referred to as 'oil') on metallic or metalliferous matter. The invention depends upon the application of the following facts: First, when a mixture of powdered metalliferous matter and gangue is treated with oil suspended in water—that is to say, in emulsion—the oil has a more or less selective action and will coat the particles of metalliferous matter in preference to the particles of gangue, while the particles of gangue will be wetted by the water; second, if the water which is mixed with the oil is acidulated with mineral, fatty, or other acid the selective action of the oil will thereby be rendered more marked and decisive; third, if the proportion of oil is kept within reasonably low limits (differing in different cases, according to the nature of the mineral to be treated and the consistency and nature of the oil) and if the mixture of water, oil, metalliferous particles, and gangue be thoroughly agitated the metalliferous particles which have become coated with oil will adhere together and form granules, which granules, partly by rea-

son of gravity or partly on account of their bulk, as compared with the individual grains of gangue, will offer ready means for separation in an up-current separator, a jig, or other similar appliance. This action is facilitated if the oil before addition to the liquor is brought into the condition of an emulsion in water containing a small percentage of soap or other emulsifying agent. These facts are utilized for the purpose of separating the metalliferous constituents from the gangue of the ore in the following manner: In a suitable apparatus, an example of which will be hereinafter described, the ground or pulped ore is caused to be violently agitated, as by a revolving stirrer, in a mixture of water and oil, the liquor being acid. As the agitation proceeds the particles of metalliferous matter agglomerate together and may be observed in the form of granules, the size of which will depend, among other things, upon the percentage of oil used. This granulation of the metalliferous constituents of the ore affords the means by which at a later stage of the process it is possible to separate the metalliferous material from the gangue, as will be hereinafter particularly described. In practice a continuous process is used—that is to say, water, ground ore, or pulp and oil, preferably emulsified, are continuously fed into a series of vessels, and the products of the agitation are continuously fed into an up-current separator or jig or similar device, which in the case of the up-current separator separates the metalliferous granules from the gangue by allowing them to fall to the bottom of the vessel and to be carried away by a downward stream, while the particles of gangue are carried away by an upward stream.

* * * The proportion of oil used depends upon its viscosity, the fineness of the ore and other factors, and the consistency and size of the mineral granules desired. The more oil used the larger, softer, and less numerous the granules. With, say, ten per cent. of oil to the weight of metalliferous mineral a few pasty masses of oil-

agglomerated metalliferous mineral matter will generally result. Oil in excess of this may cause all the granules to coalesce into one soft mass. Usually an amount of oil varying from four per cent. to six per cent. of the weight of metalliferous mineral matter present in the ore yields granules of suitable size, consistency, and specific gravity for ready separation from the gangue in the up-current or other apparatus used for classification."

All of the claims of patent No. 777,273 are restricted to a process by which the oil-coated metalliferous matter is agglomerated into granules and the granules by classification separated from the gangue. And the same is true of all the claims of patents No. 763,259 and No. 763,260, above mentioned. It is also true of both claims of patent No. 777,274, of December 13, 1904, to Cattermole, Sulman and Picard. Shortly before March, 1905, Sulman, Picard and Ballot instructed A. Howard Higgins, one of the plaintiff's experts, to investigate by experiments, certain points in their bearing upon the Cattermole process of granulation. They were as follows:

- "(1) Influence of acidity on granulation,
- (2) Influence of temperature on granulation,
- (3) Influence of speed of Gabbett agitation on granulation,
- (4) Influence of ratio of ore to liquor on granulation,
- (5) Influence of metallic salts on granulation,
- (6) Influence of the size of particles and of the influence of slimes on granulation,
- (7) Influence of the amount of oil on granulation."

And the above points were to be determined on "(a) oleic acid, (b) residuum oils." In consequence of his investigations Higgins made a report March 16, 1905, on granulation as affected by the percentage of oil used, in which he said:

“The effect of diminishing the percentage of oleic acid is to alter the type of oiling; the higher percentages producing granules, and the lower ones froth. 6% of the oleic acid on the *mineral* is sufficient to form good granules without much froth. This froth consists of insufficiently oiled mineral mixed with large quantities of air. As this percentage of oleic acid is decreased, the time for clean up of the sands is increased and more froth is formed. 0.62% oleic acid on the mineral is insufficient to form any granules and nearly the whole of the mineral comes to the surface, on stopping the cone, as froth. 0.2% acts in the same manner leaving the coarse sands with rather more mineral in them. (This is 0.1% on Broken Hill Ore.) In all cases the oil has been measured in cubic centimeters and the percentage calculated as though they weighed grams but as the specific gravity of the oleic acid is less than unity this is not the case, and all percentages will be lower than those actually given.”

There was, I think, patentable invention in the discovery thus made in March, 1905. Prior to that time there had been no suggestion in the art that the proportion of .1% of oil to ore or of any other fraction of 1% of oil to ore would or might result in successful concentration. Further, the result reached was an utter surprise. Experiments were conducted with reference to the Cattermole process, and all of the Cattermole patents required the formation and sinking of granules containing the metallic particles, and not their flotation. The teaching of that process was that the metallic particles should go to the bottom and that of the process of the first patent in suit that they should go to the top. But while the ascertainment that such a minute proportion of oil would effect a successful concentration of ore through a flotation process was a discovery, it was nevertheless of such a character, viewed with respect to the circum-

stances under which it was made, as to involve invention and confer patentability. The statutes provide for patenting new and useful inventions and discoveries, but a bare discovery unaccompanied by the exercise of any invention in reaching it or utilizing or reducing it to practice would not justify or support a monopoly in the discovery. In the present case, however, the facts disclose not a bare discovery, but a discovery coupled with invention in usefully applying it. In such cases patents properly may be granted. The defendant lays much stress upon the proposition that the reduction of the amount of oil in the process for the concentration of ore did not and could not involve patentable invention, but only an ascertainment of the proper degree in which oil should be used, which was readily discoverable by any one competent to conduct or superintend a process of ore concentration; and further, that motives of economy would naturally have suggested a reduction in the quantity of oil to the extent of its excess over what was necessary for the accomplishment of the purposes of the process. But if such a reduction was obvious, why is it that it was never made prior to the discovery in question? The fact that economy required the use of the least quantity of oil sufficient for the conduct of the process affords cogent evidence that the feasibility of effecting a reduction was not obvious, but properly the subject of patentable invention. No one to-day understands how the use of only .1% of oil operates to secure the mineral froth of the first patent in suit. This is testified to by the experts and is admitted on both sides. If the principle of operation of the discovery is insolvable to the human mind to-day it could not have been predicted or anticipated by the human mind in March, 1905. The fact that the underlying principle of the process was not understood by no means nega-

tives patentability. In *Diamond Rubber Co. v. Consol. Tire Co.*, 220 U. S. 428, the Court said:

“A patentee may be baldly empirical, seeing nothing beyond his experiments and the result; yet if he has added a new and valuable article to the world’s utilities he is entitled to the rank and protection of an inventor. And how can it take from his merit that he may not know all of the forces which he has brought into operation? It is certainly not necessary that he understand or be able to state the scientific principles underlying his invention, and it is immaterial whether he can stand a successful examination as to the speculative ideas involved.”

This case is unlike those in which the discovery of the use of an element in a process in the degree insuring the best results is a matter within the competency of those skilled in the art, but, on the contrary, is one where clearly there was patentable invention or discovery in ascertaining the degree. The experiments made with respect to the Cattermole process were initiated with a view to its improvement and the securing of granulation of a higher efficiency. The prosecution of the experiments relating to a sinking and not a flotation process would naturally tend to divert the mind from the contemplation of any process of the latter character. Pertinent to this point is the following testimony of Mr. Higgins:

“I do not remember anything being said about the quantity of oil, except the quantity used was always adjusted to give granulation.

44Q. In adjusting the oil to give the best granulation, I presume you experimented with different quantities of oil?

A. Yes, there may have been different quantities, but whenever the granulation became imperfect by reason of the drop in the quantity of oil, the oil was naturally increased.”

I perceive no escape from the conclusion that the discovery was patentable. To decrease the amount of oil used in an old process, so long as the characteristic mode of operation and result of such process are preserved, even though in less degree, does not as a general rule involve invention. But when the old mode of operation and its result through a decrease in the amount of oil disappear and a new and different result is disclosed the change ceases to be one of mere degree, and may support a patent monopoly in favor of one whose inventive genius or research has discovered the process. The patentability of the process of the first patent in suit resides in the use of only the minute quantity of oil contemplated by the patent. The reduction of the oil to this quantity effected a change, not merely in the degree, but in the "type of oiling," leading to results which cannot be accounted for on the assumption that a mere change in degree as distinguished from patentable discovery was involved.

The defendant contends that a substantial increase in the amount of oil used will not affect the nature or efficiency of the process of separation, but will only add to the cost by carrying it on with an unnecessary amount of oil. But this position is in conflict with the decided weight of the evidence and with the showing of the experiments conducted by Higgins at and immediately prior to the time of the discovery. It is satisfactorily proven that the process of the first patent in suit, depending upon the selective affinity of the air-bubbles in the mixture for oil-coated metallic particles, that affinity is strongest when the film of oil surrounding the metallic particles is so thin as to be imperceptible to the senses, and that with any substantial increase in the quantity of oil on the metallic particles the character of the process is changed and its efficiency diminished for some reason as yet unrevealed.

A great advance in the art of ore concentration has resulted from the process of the first patent in suit in the efficient recovery of slimes. With the use of that process ore may be so finely ground as to insure the thorough separation of the metallic particles and gangue, and great savings effected. The profit so saved in a single year from the output of the principal porphyry copper mines, including the defendant's, has been estimated by one of the expert witnesses as more than \$17,000,000. In *Moore Filter Co. v. Tonopah-Belmont Development Co.*, 201 Fed. 532, 540, the circuit court of appeals for the third circuit, in dealing with an ore concentration case, said:

“When, therefore, Moore disclosed a process by which such recovery was made enormously profitable, and by which he turned a dump heap, which, under all known processes, machines, and laboratory methods, was worthless, into profitable ore, we are constrained to give little weight to the suggestion that his process was either anticipated, a mere advance incident to the art, or involved no invention.”

The defendant sets up as part of the prior art to negative invention United States patent No. 689,070 of December 17, 1901, to A. S. Elmore. This patent was for an “Improvement in separating mineral substances by the selective action of oil,” and contains but one claim as follows:

“The process for separating metallic and rocky constituents of ore which consists in mixing pulverized ore with water and mixing the ore and water with oil in the presence of an acid, allowing the mixture to rest whereby the oil having the metallic substances entrapped in it floats at the top of the mixture, and separating the metallic constituents from the oil, substantially as described.”

In the description it is stated:

“The selective action of oil has been utilized for separating metallic substances from earthy or rocky constituents of ores. This has generally been done by pulverizing the ore and suspending it in a considerable quantity of water, so as to make a freely-flowing pulp, then mingling with it oil, preferably heavy oil, such as is obtained from petroleum after some of the lighter oils have been distilled from it. When the mixture rests, the oil, with most of the metallic substances entrapped in it, floats at the top and is separated from the rocky or earthy matters, which are run off with the water as tailings. The oil is afterward separated from the metallic substances, usually by centrifugal action.”

The patent nowhere states the amount of oil which is to be used or the ratio between the weight of the oil and the weight of the ore or its metallic content. It, however, clearly appears from the evidence that the process was what has been termed a “bulk oil process,” employing from one to two and a half or three tons of oil to each ton of the pulverized ore to be treated. By reason of the large amount of oil used and the loss of a considerable proportion of it in operation the process was expensive and unsatisfactory. There was but a small recovery from the slimes, probably for the reason that the extremely minute metallic particles contained in them did not yield to centrifugal action employed in the separation as readily as the larger particles. The Elmore bulk oil process was litigated abroad in *Minerals Separation Ltd. v. British Ore Concentration Syndicate, Ltd.*, which was an appeal to the House of Lords by the plaintiff herein from a judgment of the Court of Appeal, holding that it had infringed the A. S. Elmore British patent No. 11,307 of 1901, corresponding substantially with United States patent No. 689,070 of

December 17, 1901, to A. S. Elmore. The judgment of the Court of Appeal was reversed by the House of Lords. The opinions delivered to that house differed with respect to the validity of the A. S. Elmore patent, but it is to be gathered from the opinions so delivered that the plaintiff herein was held by the House of Lords not to have infringed. Lord Shaw said:

“The question is, have the Appellants infringed this patent? In order to determine this question it is necessary to look at the patent under which they work, viz., 7,803, of 1905, for ‘Improvements in or relating to ore concentration,’ granted to Sulman, Picard and Ballot. The complete specification is dated 2nd June, 1905. My Lords, one cannot peruse that specification without being struck by the fact that at all events the mixture to which the application of acid was to be made was of a very different character to that described in the Elmore patent. And the striking difference occurs in this, that the oil in the Appellants’ mixture, instead of being from one to two-and-a-half tons per ton of ore to be treated is only from two to three pounds per ton of ore to be treated.

The next contrast is this. As already shown the natural law relied upon in the Elmore patent was the lesser specific gravity of oil which, operating in bulk upon the mineral particles, would carry them to the surface of the mixture when it rested, and thus effect the separation aimed at, viz., the separation of those mineral particles from the rest of the ore. But it would have been absolutely impossible for such flotation and separation to have occurred with the minute fraction of oil used in the Appellants’ process, however much acidulation had been employed. * * * How then was the flotation of mineral particles to the top of the mixture, and thereby the method of separation of these from the gangue to be accomplished? My Lords, it is in the answer to that that four-

fifths of the specification and claim of the Appellants consist. That is to say, they are not promoting a method of separation which had before been described, but they are engaged upon a new method of separation. Instead of relying upon the lesser specific gravity of oil in bulk they rely upon the production of a froth by means of an agitation which not only assists the process of the minute quantities of oil reaching the minute particles of metal, but forms a multitude of air cells, the buoyancy of which air cells, forming around single particles of the metal, floats them to the surface of the liquid."

The process of the first patent in suit was also considered in *Ore Concentration Company, Ltd. v. Sulphide Corporation, Ltd.*, in the Supreme Court of New South Wales, and on appeal in the Privy Council of Great Britain. The action in the court below was brought by the owner of and a licensee under British patent No. 10,001 of 1900, to F. E. Elmore, and British patent No. 11,307 of 1901, to A. S. Elmore, to restrain the infringement thereof by a licensee of the plaintiff herein conducting the process of the first patent in suit. The suit was abandoned at the trial with respect to the F. E. Elmore patent, and was dismissed by the Court below as to the A. S. Elmore patent, July 24, 1911. On appeal the Privy Council affirmed the judgment of the Court below, March 6, 1914. The case turned on the questions of the validity of the A. S. Elmore patent and its infringement by the licensee of the plaintiff herein, no reference being made to the first patent in suit or the corresponding British patent, although the novelty of the process was recognized. With respect to the general nature of the A. S. Elmore process and the alleged infringement by the process of the first patent in suit it was said by Lord Parmoor, who delivered the judgment:

“The patent commences with a narrative statement of the method by which the selective action of oil has been utilised to separate metals and metallic substances from gangue. This is said to be generally done by pulverising the ore and suspending it in a considerable quantity of water, so as to make a freely flowing pulp, and then mingling it with oil, preferably heavy oil. The effect is that most of the metallic substances are entrapped in the oil, and when the mixture rests, the oil floating on the top is separated from the gangue which is run off with the water as tailings. * * * Unless the oil used has sufficient tenacity to retain the entrapped metallic particles separation would not be effected. The oil is afterwards separated from the metallic substances usually by centrifugal action.* * * The real difficulty which their Lordships have to determine is whether the Respondents in the process of separation which they employ, entrap or coat and hold or carry the metallic particles in oil, using oil as the selective agent. The Respondents deny that they in any way use the Appellants’ invention, and say that their process is essentially distinct, and that its successful operation depends on the law of surface tension. It is not incumbent on the Respondents to explain the law on which the success of their process depends. * * * Apart from any question of theory, the Respondents use oil in their process under conditions which make it almost impossible to entrap or coat and hold the metallic particles by the selective agency of oil. The Respondents use a thin oil at a temperature of 120° Fahr., the quantity is minute, not more than 2 or 3 pounds to a ton of ore, or about 2 or 3 pints of oil to 10,000 pints of water; the resulting concentrate is practically free from oil and no mechanical contrivance to separate the oil from the metallic particles is required or used.”

The judgment concluded with the statement that “their Lordships find that the respondents do not

either directly or indirectly use the invention claimed by the appellants, but a process essentially distinct, and that there is no infringement." While, as already stated, the validity of the first patent in suit was not before the court in either of the British cases, but the question of infringement by the practice of that process, the opinions delivered in the House of Lords, as well as the decision of the Privy Council in declaring that the process covered by the first patent in suit was one "essentially distinct" from the Elmore process, are entitled to much weight. It is too clear for further discussion that the bulk oil Elmore process in no way affects the validity of the first patent in suit.

The defendant sets up as an anticipation of the first patent in suit the Haynes British patent No. 488 of 1860. I am satisfied that the Haynes patent is not an anticipation, and, equally, that as part of the prior art it cannot operate to negative invention. In the first place, aside from all other features, the patent does not limit the quantity of oil, fatty or oleaginous matter to the oil proportions of the first patent in suit, and, secondly, the patent does not require agitation of the pulp other than such as may result from the passage of the same into a "tritulating machine." And it appears from the testimony of Dr. Sadtler that without the use of some means to produce agitation not mentioned in the patent its process will not produce mineral froth flotation. Dr. Liebmann states that the process is "quite impracticable" and "quite impossible," and further testifies:

"Q. 10. And what have you to say as to whether or not you find, in this patent, a disclosure of a process for producing a froth by agitation? A. I have never found one. I should add to that, I think it is impossible to find one with the data given in this patent."

In the Judgment of the Privy Council reference was made to the Haynes British patent as follows:

“It was known many years prior to 1901 that oil, by its affinity to metal, operated to differentiate metal from gangue in a mixture of oil, water and ore. Haynes’s patent, published in 1860, describes a method of separation of metal from gangue by the use of an agent containing fatty or oleaginous matter. This document is, however, not more than an indication of the date at which attention was first directed to the affinity of oil for metals.”

Two patents to Edmund B. Kirby, No. 809,959 of January 16, 1906, applied for December 14, 1903, for an “Improvement in process of separating minerals,” and No. 838,626 of December 18, 1906, applied for December 17, 1903, for an “Improvement in separating tanks,” are relied on by the defendant as part of the prior art. The process patent recommends from 25% to 75% of oil to the ore, stating that “preferably the pulverized ore is mixed with three to five times as much water, by weight, and to this is added a sufficient amount of the kerosene-bitumen solution, excellent results being obtained by using one-fourth to three-fourths as much by weight as ore.” It is fair to assume that Kirby would not have specified oil to the extent of from 25% to 75% on the weight of the ore had he deemed it practicable or possible to do with less. An examination of the process patent and of the evidence relating to it shows, I think, that the patent contemplated an oil buoyancy flotation in contradistinction to the metallic air froth of the first patent in suit, and was for a different process, not suggestive of that of the latter, with its economical and successful use of a fraction of only one per cent. of oil. The Kirby apparatus patent No. 838,626 is for a separating-tank intended for use in the Kirby process. In view of what has been said

touching that process the apparatus patent does not call for discussion.

The defendant sets up as part of the prior art a number of patents granted to Alfred Schwarz, but offered in evidence only three of them, No. 807,501 of December 19, 1905, applied for April 19, 1905; No. 807,502 of December 19, 1905, applied for May 27, 1904; and No. 807,503 of December 19, 1905, applied for May 27, 1904. All of these patents relate to the concentration of ores. Although offered and admitted in evidence no testimony has been adduced by the defendant in explanation of any of them, nor have counsel for the defendant made any argument in support of them. It is unnecessary to consider patent No. 807,501 as owing to the fact that the invention of the first patent in suit was made early in March, 1905, and before the date of application of the former patent, that patent cannot be treated as part of the prior art with respect to the first patent in suit. There is no evidence that any process under either patent No. 807,502 or patent No. 807,503 was carried on as part of the prior art, and evidently each of them requires the use of a larger quantity of oil than the minute proportion required by the first patent in suit; the former stating that "the selective agent being added in sufficient quantity to thoroughly saturate the ore and to make a thick pasty mass," and "the metallic constituents adhering to and being entrapped in the resinous and oil or fat compound will be buoyed up thereby and rise to the top," &c., and the latter, that "the ore is mixed with sufficient of the selective material to make a thick pasty mass, the agitation being continued long enough to bring the selective material into intimate contact with all portions of the ore," and "the mass is then allowed to subside, when the selective material, with the entrapped metallic constituents of the ore, will rise to the top," &c. There is, I think, no evidence or

legitimate inference to warrant the conclusion that either of these patents can affect the validity of the first patent in suit.

The defendant also relies upon patent No. 348,157 of August 24, 1886, to Carrie J. Everson, for an "Improvement in processes for concentrating ores," as part of the prior art. The patent specifies two methods of conducting the process. It is admitted that the first method requires oil amounting to 5% on the weight of the ore. With respect to the second method it is stated in the patent description:

"I have found three fluid drams of oil abundant for properly moistening two ounces of heavy ore, or in the ratio of about a barrel of oil to the ton of ore, the amount being, of course, variable with the relative bulkiness of the ore."

Dr. Liebmann testifies that the oil used in the process was 16.5% of the weight of the ore, and Dr. Sadtler says that the amount of oil so used was from 16% to 17% of the weight of the ore. The Everson process has never been used commercially and Dr. Liebmann states that it could not be so used; that "it is not a process for large scale operations"; but that there was a possibility of its application to gold and silver in small quantities. Dr. Sadtler expresses no opinion upon the applicability of the Everson process to the concentration of ore on a commercial scale, and states, in substance, that he had never practiced the Everson process in either of the methods disclosed in the description of the patent. The defendant argues that in the Everson process the concentrate "could not possibly float by the bulk oil flotation principle, for the simple reason that the amount of oil was insufficient for that purpose", that with the use of only 17% of oil no bulk oil flotation is possible; and that the process "could not have resulted in surface tension flotation, skin flotation or film flota-

tion, so-called, for the simple reason that the conditions for that form of flotation were absolutely wanting." But this contention fails, I think, to negative patentable invention in the process of the first patent in suit. I am not satisfied by any experiment or demonstration made in the case that the process described in the Everson patent would produce the economical and efficient concentration secured by the process of the first patent in suit. Certainly, were there nothing else, a reduction in the quantity of oil from 17% or even 5% to a fraction of 1% on the weight of the ore, under circumstances similar to those attending the discovery of the sufficiency of that minute proportion for successful metallurgical operations would be sufficient to confer patentability.

An analogy is furnished in *Loom Co. v. Higgins*, 105 U. S. 580, where Mr. Justice Bradley, delivering the opinion of the court, said:

"It was certainly a new and useful result to make a loom produce fifty yards a day when it never before had produced more than forty; and we think that the combination of elements by which this was effected, even if those elements were separately known before, was invention sufficient to form the basis of a patent."

The defendant also relies upon a newspaper article taken from the *Daily Herald Democrat*, of Leadville, Colorado, October 30, 1889, referred to as "Fryer Hill Publication," and an article taken from the *Engineering and Mining Journal* of November 10, 1890, referred to as "Criley and Everson Publication," as part of the prior art. It appears that both articles refer to tests or experimental applications of the process of the Everson patent, with some slight modifications. Neither of these articles contains anything rendering it necessary to add to what has been said in direct connection with the Everson process.

Much stress is laid by the defendant upon an article in the California Journal of Technology of November, 1903. This article was prepared by three young men, students in the class of 1903 in the mining department of the University of California, and is entitled "Experiments on the Elmore process of ore concentration." This article is suggestive, but cannot, I think, be justly treated as negating the exercise of invention with respect to the process of the first patent in suit. The experiments were laboratory tests and did not disclose or suggest the idea that such a minute quantity of oil as one-tenth of one per cent., or any fraction of one per cent., on the weight of the ore could be efficiently and successfully employed in ore concentration. There were a number of tests with respect to the concentration of molybdenite ore with percentages of oil to ore running from 2.1% to more than 100%, with the result that the highest extraction of molybdenite sulphide was obtained by the use of 8.9% of oil; the extraction in that case being 75% as against an extraction of 43.5% obtained by the use of 2.1% of oil. The teaching of these tests was that 2.1% of oil, was less efficient than the use of 8.9%, and the article as a whole, far from suggesting the possibility of the use of only a fraction of one per cent. of oil points to an opposite conclusion.

The defendant contends there is nothing new in the employment of only a fraction of one per cent. of oil relative to the weight of the ore in the process of the first patent in suit, for the reason that, as alleged, an equally small proportion of oil was used in the process of the Cattermole Patent No. 777,273, mentioned in the first patent in suit. The Cattermole patent mentions from four to six per cent. in weight of oil to the weight of the metalliferous mineral present in the ore, and consequently, under the Cattermole proc-

ess the amount of oil to be used depends upon the weight of the metalliferous mineral, and not upon the weight of the entire ore, and there is evidence to the effect that the larger part of the copper ores mined and concentrated in this country contain about two per cent. of copper. Hence the argument is made by the defendant that the weight of oil employed in the Cattermole process is only from .8% to .12% of the weight of the copper contained in the ore, and that any proportion of oil less than one per cent. of the weight of the ore comes within the quantity mentioned in the first patent in suit, namely, "a fraction of one per cent. on the ore." This contention ignores the following statement in the description of the Cattermole patent now considered:

"In certain cases, as where but little mineral is present in the ore, to increase the nucleating or granulating factor pulverized mineral matter obtained in a previous operation or other matter having an affinity for oil from a different source may be introduced into the ore, or a portion of already granulated and separated mineral matter may be returned to maintain the necessary amount of mineral in the ore under treatment."

It is evident that the weight of "pulverized mineral matter" introduced to "maintain the necessary amount of mineral in the ore under treatment" is, for the purpose of determining the necessary amount of oil, to be added to "the weight of metalliferous mineral matter present in the ore." Such must be the meaning of the patent or it is insensible. And this accords with the requirement in the seventh claim of "adding particles of material having an affinity for oil to assist in the formation of granules of oil-coated particles." The defendant has made no demonstration, as might have been done, of the amount of oil required by the Cattermole process in its application to lean copper ores, but

indulges in speculation and conjecture on that point. The defendant contends that in the Cattermole process of the above patent there were necessarily two degrees of agitation of the mixture; the first being violent and the second gentle. On the assumption that two degrees of agitation were required in the Cattermole process; first, violent agitation of the mixture in order to bring the oil into intimate contact with the mineral particles; and, secondly, the subjection of the mixture to a slower or rolling form of agitation to cause the agglomeration of the oiled metalliferous particles and the formation of granules, it by no means follows that with the omission of the second step the mineral froth of the process of the first patent in suit would have been formed, had there been in the mixture oil in excess of the proportions contemplated by that patent. And if it be further assumed that the mixture containing oil and other elements in Cattermole proportions can first be violently agitated so as to produce a froth and then slowly agitated so as to produce granules, and again violently agitated so as to destroy the granules and restore the froth, and so on by alternation, and that, the mixture remaining the same, the production of froth on the one hand, or granules on the other, is simply a matter of manipulation, it is not to be inferred that the froth so formed with Cattermole proportions of oil would be the froth of the first patent in suit. Dr. Liebmann, for the purpose of distinguishing between the Cattermole process and that of the first patent in suit, during the trial conducted two experiments, identical in their nature, save that in one a larger amount of oil was used than in the other. In the former case granules were formed which sank; and in the latter a mineral froth was formed, the agitation and other factors being the same. 3.6% of oil and .1% of oil were respectively used in the two experiments. Both were performed in the same appa-

ratus with similar materials and manipulation. These experiments served to show that the variation in the amount of oil used, other things being equal, may result in the formation of the mineral froth of the first patent in suit, or in the formation and sinking of the granules of the Cattermole process. In this connection it is to be observed that the Cattermole patent in its descriptive portion states:

“With certain ores it may be preferable to use in some stages of the process a rolling form of agitation, as in cylinders or barrels, to obtain good granulation of the mineral.”

The description of the patent nowhere specifies that its process is necessarily dependent upon two degrees of agitation, one violent and the other slow or rolling, and in none of the seven claims of the patent, with the exception of the fifth, in such a requirement mentioned or suggested. In that claim only is there a provision for “further agitating the mass to increase the size of the granules,” and even in that claim there is no suggestion of a difference in degree between such further agitation and the agitation which has preceded it. For the foregoing reasons I think that the contention of the defendant that the quantity or proportion of oil used in the Cattermole process was not materially in excess of that used in the process of the first patent in suit, and that, not a difference in the quantity of oil, but a resort to two degrees of agitation was essential to the formation of Cattermole granules, cannot be sustained.

The defendant also relies upon two patents granted to Alcide Froment; one of them being British patent to Henry Harris Lake, communicated by Alcide Froment, No. 12,778 of 1902, and the other an Italian patent to Froment, No. 63,723, the specification of which is dated May 20, 1902. The Froment Italian patent

was in the French language, and there is an English translation in evidence. The process covered by this patent was entitled "A process for enriching sulphide and copper ores, lead ore and blende by gases combined with fatty bodies." The inventor stated as phenomena which had been studied by him and served as the basis of the patented process the following:

"1. When the natural sulphides reduced to fine powder are moistened by a fatty substance, they have a tendency to unite in spherules and to float upon the surface of water.

2. This tendency is simply retarded by the specific weight, and opposed by the gangue which imprisons the moistened sulphides in its pulverulent mass.

3. If a gas of any kind is generated in this mass, the bubbles of this gas become covered with an envelope of sulphides and thus rise readily to the surface of the liquid where they form a kind of metallic magma.

4. The formation of these metallic spherules is singularly active, if the gas is in a nascent state."

The weight of the evidence is that the quantity of oil to ore necessary for the conduct of the process specified in the patent would amount to from 12% to 15% of the weight of the ore, and this seems to accord with the statements in the patent that a "kind of metallic magma" is formed and that "the metallic spherules pressed one against the other, will become grouped in a magma clearly separated from the remainder of the liquid." These statements, I think, are inconsistent with any idea that under the Froment process the metallic particles were coated with oil of the extreme thinness characterizing the process of the first patent in suit; the thickness of the film in that process, according to scientific evidence, being only one one hundred thousandths part

of an inch and imperceptible to the senses, as compared with a thickness of from sixteen to thirty-two one hundred thousandths of an inch in the Cattermole process and from eighty-eight to two hundred and forty one hundred thousandths of an inch in the Froment process. The British Froment patent is in substance the same as the Italian patent and in neither of them does it appear that there was present in the Froment process the very minute quantity of oil of the first patent in suit. The Froment British patent was assigned to Ballot, one of the patentees in the first patent in suit, November 17, 1903, for the benefit of the plaintiff when organized, and in the assignment Froment covenanted that he would forthwith forward or hand to the purchaser the "plans and diagrams of the plant relating to the said invention with a full description of the working of the process." Pursuant to this covenant there were transmitted to Ballot plans and diagrams and a paper, in evidence, containing a "description and instructions for the concentration of ores" under the Froment process. It is dated December 29, 1903. The instructions recommend the use of oil in proportions varying from 1% to 3½%, according to the different percentages of metal in the ore. Notwithstanding the low percentage of oil mentioned in the Froment description, I have reached the conclusion that it contained no disclosure of the process of the first patent in suit. The evidence on the subject of the Froment description is voluminous and conflicting, but there are facts and circumstances which have satisfied me that the process of the first patent in suit was not discoverable from that description by men skilled in the art of ore concentration. Dr. Liebmann states that the Froment process as disclosed in the patents as well as the Froment process as disclosed in the description are "incapable of being carried out successfully."

There is uncontradicted evidence that Sulman, Picard and Ballot, after the assignment of the Froment British patent and the receipt of the Froment description and instructions, made persistent efforts to operate the Froment process successfully, but only met with failure, and that the model apparatus sent by Froment to Ballot was treated as worthless and discarded or "scrapped." Sulman, Picard and Ballot were scientific men of large experience in the art of ore concentration, and had the Froment patents or description disclosed or suggested the process of the first patent in suit, it is to be assumed that they would have utilized it instead of prolonging their attempt until March, 1905, to perfect granulation under the Cattermole process. The fact that they did not utilize it affords the strongest evidence that the Froment description did not suggest a process in which the minute quantity of oil required by the first patent in suit could be successfully used in ore concentration.

The defendant relies on patent No. 793,808, of July 4, 1905, to Sulman and Picard, for "Improvements in or relating to ore concentration." The patent states:

"The present invention relates to the concentration of ores by separation of the metalliferous constituents and graphite, carbon, sulfur, and the like from the gangue by means of oils, grease, tar, or any similar substance which has a preferential affinity for metalliferous matter over gangue. According to this invention we utilize the power which is possessed by films or bubbles of air or other gas of attaching themselves to solid particles moistened by oil or the like."

Two methods of carrying out the invention are stated. The first is as follows:

"According to one method of carrying out our invention suitably-crushed ore is suspended

in water. To this suspension a proportion of oil, grease, or tar (hereinafter referred to as 'oil') is added and duly mixed with the mass by any suitable means in quantity insufficient to raise the oiled mineral by virtue of the flotation power of the oil alone. A suitable gas is now generated in or introduced into the mixture, such as air, carbonic-acid gas, sulfureted hydrogen, or the like, For example, bicarbonates or carbonates, either soluble or insoluble in water (preferably the latter) or easily-decomposable sulfids and the like may be used with acid solution. In such cases, if desired, the addition of acid may be made to the mixture after the addition of the gas-producing reagent. In the case of solutions containing free alkali the addition of acid sufficient to neutralize this must be made before the gas is produced. If desirable, gaseous bubbles may be produced by electrolytic methods or by means of various other known reactions."

The second method is stated as follows:

"According to another method of carrying out this invention the oil is not added alone; but the pulp is submitted to the action of a current of air or other gas bubbles, the air or other gas being first suitably charged either with the vapor of a volatile oil, such as petroleum of low boiling-point, or with the spray of any other suitable volatile or non-volatile or fixed oil or the like. The oil may be sprayed or reduced to a state of such fine division that minute globules of the same can remain temporarily suspended in an air or other gas current by the use of any suitable spraying or atomizing device and the air-current introduced into the ore-pulp, preferably at the bottom, by means of a pipe or pipes provided with suitable perforations or by other suitable contrivance. The minute oil globules or the condensed vapors or volatile oils attach themselves to the metalliferous particles in preference to the gangue."

The patent then states:

“The oiled metalliferous particles resulting from either of the processes above described have the power of attaching to themselves with a greater comparative strength than the gangue particles the films or bubbles of gas which exist in the mass and are thus raised to the surface of the liquor by gaseous flotation. They can then be removed by skimming or other suitable means. The gangue particles unwetted by oil or grease are not floated up with the oiled mineral particles, and thus in the main remain at the bottom of the vessel containing the mixture. The oil can then be removed from the oiled mineral by any suitable known means.”

There are certain features in this process as described similar to features in the process of the first patent in suit. The amount of oil coating the metallic particles being insufficient to raise them through the flotation power of the oil alone, gaseous bubbles, whether generated in the mixture, or introduced into it through the perforated spiral coil, attaching themselves to the oiled metallic particles, rise to the surface with those particles, so as to be removed by skimming or other suitable means, the gangue particles remaining in the main at the bottom of the vessel containing the mixture. This process patent, issued to Sulman and Picard upon an application filed October 5, 1903, affords cogent circumstantial evidence of the patentability of the process of the first patent in suit. I have been unable to read the description of the patent immediately under consideration without reaching three conclusions; first, that Sulman and Picard had conceived an idea, though imperfect, of an air flotation of the metallic particles; secondly, that they had no conception whatever of the possibility of conducting such a process with the minute quantity of oil specified in the first patent in suit; and thirdly,

that they contemplated the use of a very much larger proportion of oil. In view of the fact that both patentees in No. 793,808 were two of the three patentees of the process of the first patent in suit, it is so improbable as to amount to a moral impossibility that for nearly a year and a half after the filing of the application for patent No. 793,808 they should have devoted their attention and efforts to the solution of the problem of the proper quantity or proportion of oil to be used in securing improved granulation in the Cattermole process, and have been astonished at the making of the discovery in March, 1905, if they had recognized or believed that an economical and efficient process of ore concentration could be carried on by the use of oil amounting to only a fraction of one per cent. Any further discussion of patent No. 793,808, I think, is unnecessary.

I have found nothing in the prior art to anticipate the process of the first patent in suit or to negative invention. Objection has been made that the disclosures of the patent are not sufficient, in that the application of the process to different ores necessitates some difference in treatment involving a variation in temperature, or in the amount of acid or of oil, and the patent omits to specify the degree or amount of such variation with respect to the treatment of the different ores. But to require of an inventor such a specification would be to demand an impossibility. The patent recognizes that different ores may require a different treatment. The description states:

“The proportion of mineral which floats in the form of froth varies considerably with different ores and with different oily substances, and before utilizing the facts above mentioned in the concentration of any particular ore a simple preliminary test is necessary to determine which oily substance yields the proportion of froth or scum

desired. * * * The minimum amount of oelic acid which can be used to effect the flotation of the mineral in the form of froth may be under 0.1 per cent. of the ore; but this proportion has been found suitable and economical."

And claims 1 and 12 mention oil amounting to "a fraction of one per cent." A close or exact adjustment of quantities and proportions of oil in the treatment of different ores within the limits prescribed in the patent is a matter calling, not for the exercise of inventive genius, but for the skill of the metallurgical engineer conducting or superintending the operation. In *Mowry v. Whitney*, 14 Wall. 620, the court said:

"The specification, then, is to be addressed to those skilled in the art, and is to be comprehensible by them. It may be sufficient, though the unskilled may not be able to gather from it how to use the invention. And it is evident that the definiteness of the specification must vary with the nature of its subject. Addressed as it is to those skilled in the art, it may leave something to their skill in applying the invention, but it should not mislead them."

Some embarrassment in the treatment of this case has been caused by the use of different adjectives and descriptive phraseology as applied to the same thing. If a patent for a process of ore concentration, or any other process, clearly sets forth the ingredients and the practical steps to be observed in conducting it the misuse of terms as applied to the operation of natural laws involved in the process is immaterial. In the administration of justice it is the aim of courts to deal with substance and not to be influenced by mere form not calculated to mislead as to substance; and where a material and substantial thing is plainly identified in the patent claims and description a mistaken misnomer is harmless and negligible. Inventors are not required to understand the natural laws under which new and

useful results are obtained from ingredients, elements, apparatus and manipulation requisite for the conduct of the process. There are occult laws, unknown and inexplicable, to which tangible results must be attributed. In the nature of things an inventor, so long as he clearly sets forth the practical means and steps for securing those results, does all that the law requires or can reasonably be expected of him. So, it is unimportant that to the same thing one name may be applied by one person and a different name by another, the identity clearly appearing. The truth of this statement has been strikingly exemplified in this case in the language of patents and other publications, judicial decisions, the oral testimony and the arguments of counsel.

During the trial a large number of experiments were made for the purpose of illustrating ore concentration processes described in patents and other printed publications of the prior art. Such experiments are illuminating and helpful, or deceptive and misleading, according to the conditions under which they are performed. As a general rule, in such experiments processes of the prior art should be illustrated by means of apparatus of the prior art in which such processes were conducted at or about the time of invention and under the conditions then understood and observed. To construct apparatus long after, and in view of subsequently acquired knowledge, in order to show a prior process tends to produce embarrassment and confusion touching the nature and operation of the process inquired into. In *Naylor v. Alsop Process Co.*, 168 Fed. 911, the circuit court of appeals for the eighth circuit said:

“An expert, however, cannot take a process patent which has never been applied industrially and work the process in his laboratory and discover therefrom something which is not disclosed on the face of the patent, and then transfer that

experience back to the time of the patent, and make it a part of the prior art for the purpose of defeating a meritorious invention."

In *Schmertz Wire Glass Co. v. Western Glass Co.*, 178 Fed. 977, the court said:

"By using twentieth century magnifying glasses, a nineteenth century method has been found efficient, which never was so before, and the immensely important point of view of an advanced art is thus unfairly used to discover an original conception never acted on or made anything of, and which never had any practical or beneficial existence."

The material question for the court is not whether any given apparatus is capable, under manipulation employed in view of existing knowledge, of carrying on the prior process inquired into, but whether the process was carried on as part of the prior art, and, in case of an ore concentration process, by way of illustration, under what conditions as to ingredients, strength and extent of agitation and other essential factors; and only so far as those conditions are reproduced and faithfully observed in demonstrations in court, due allowance being made for the difference in the requirements of mill operations, is the experiment entitled to probative force. The difference between the conduct of the process in the mill and the necessarily interrupted or broken character of the process as disclosed in experiments in court and laboratory tests in subsequently constructed apparatus must be borne in mind in determining the weight to be given to such experiments or tests.

On the whole I am satisfied that the first patent in suit must be sustained as to claims 1 and 12, but not as to claim 9. The two former are definite, specifying and limiting the amount of oil to be used; claim 1 men-

tioning "a small proportion * * * amounting to a fraction of one per cent. on the ore," and claim 12 "a fraction of one per cent. of oil on the ore." Claim 9 mentions "a small quantity of oil." This is so indefinite as to render the claim void, unless on consideration of the patent as a whole the claim can by construction be limited to the use of oil amounting to only a fraction of one per cent. The patentability of the process of the first patent in suit resides in the use of oil in the extremely minute proportion disclosed in the descriptive portion of the patent to effect separation of froth with its metallic particles from the remainder of the mixture by flotation. The amount there disclosed is not in excess of "a fraction of one per cent. on the ore" and may be only one-tenth of one per cent. on the ore, or even less. If, then, by construction claim 9 should be so limited as to be restricted to the use of oil amounting to only a fraction of one per cent. on the ore, that claim is in substance, though not in exact phraseology, the same as claim 1 for the reason that in any event from the nature of the invention it would be necessary to read "by flotation" into claim 9, if in other respects valid. But a limitation by construction producing such a result is inadmissible. It is suggested by one of the plaintiff's counsel in his consideration of claim 9, that one for the purpose of securing immunity from the consequences of infringement might use an oil useful in the process, and add to it an oil not useful as applied to his particular ore, and, on being sued for infringement contend, "I am using 1.1% of oil. I do not infringe. I am using more than a fraction of 1% of oil." But the existence of this possibility does not, I think, warrant such a construction of claim 9 as is urged; for the disclosure of the patent does not extend to the use of 1.1% of oil, but is limited to a fraction of 1%. If it be assumed, however, that the claims in suit contemplate and

require the use of efficient, as distinguished from inefficient, oil, and if in the case suggested an inoperative oil should be used by way of addition to the efficient oil so contemplated and required it might be a question, upon which, however, no opinion is here expressed, whether the addition of the inoperative oil to the efficient oil could be treated as an increment to the amount of oil so contemplated and required, operating as a shield to protect the wrongdoer. But this question would arise in a suit based upon claim 1 or 12, as well as in a suit based upon claim 9, were it proper by construction, in order to save it, to limit "a small quantity of oil" to a quantity of oil amounting only to a fraction of one per cent. on the ore, and therefore fails to require or justify the suggested limitation of claim 9, without which it must fall.

On the question of infringement of the first patent in suit I have no doubt. It was practically admitted by counsel for the defendant in opening the defense that it had infringed the three patents in suit by its operations at Miami within four months next before the filing of the bill; he stating "in the first installation which was made at Miami, we make no serious contention that it did not represent the operations set forth in the three patents in suit." It appears that the infringing operations were carried on in apparatus built in imitation of the plaintiff's standard machine. But the defendant denies that it infringed by its concentration of ore in its pneumatic flotation plant through its practice of the process of patent No. 793,808 of July 4, 1905, to Sulman and Picard, hereinbefore discussed, as modified by the use of what is known as the Callow cell. Counsel for the defendant, however, stated with respect to the process of the patents in suit and the process as carried on by the defendant under the Sul-

man and Picard patent, with the apparatus of the Cal-low cell:

“The broad principles are the same in both. In both we have the pulp, consisting of ore held in suspension in water. In both the water is modified to lower its surface tension. In both the buoyancy comes from air-bubbles.”

The defendant in its operations also used the minute proportion of oil mentioned in the first patent in suit. It does not use acid in its process; but this fact is immaterial so far as the question of infringement is concerned for the reason that it appears both from the claims and the description of that patent that the use of acid is optional, the description stating that “the water in which the oiling is effected is preferably slightly acidified,” and claims 1 and 12, as well as claim 9, unlike a majority of them, not requiring acid. The defendant’s counsel also stated that the difference between its process and that of the complainant “comes after the air-bubbles have attached themselves to the mineral particles.” I do not think there is any such difference between the processes as to negative infringement. It was in substance admitted on the part of the defendant that if the first patent in suit is a pioneer patent and properly drawn the operations carried on at Miami were an infringement. Whether that patent is technically a pioneer patent or not, it certainly was highly meritorious and, I think, partook of the nature of a pioneer patent so far as the very successful use of oil amounting to only a fraction of one per cent. is concerned. Its claims merit much liberality of construction and when so construed embrace the operations of the defendant at Miami. The purpose of each process is the concentration of the ore through the separation of the metallic particles from the gangue. In the plaintiff’s

process the separation is effected through the rising of air-bubbles to which are attached the metallic particles, through the mixture to the top, and the formation of a froth or scum on the surface, which can by simple means be removed with the contained metallic particles. In the defendant's process the separation is effected through the rising of air-bubbles to which are attached the metallic particles through the mixture to the top and the floating away into a launder of either the original bubbles to which the metallic particles were first attached or succeeding and oncoming bubbles which have caught and buoyed up to the surface the metallic particles escaping from bursting bubbles. By the use of a launder a recovery of the metallic particles is readily effected. The defendant contends that since its abandonment of its original infringing process at Miami above referred to, it has not and does not infringe the first patent in suit, for the reason that it does not in its process produce the coherent and permanent froth of the process of that patent. It appears from the evidence, it is true, that the bubble froth in the defendant's process is not as coherent and permanent as the froth of the process of the first patent in suit; but both are mineral froths, and that of the defendant is sufficiently permanent to effect through air flotation an efficient separation of the metallic particles from the rest of the mixture. Air-bubbles, however produced, in water not modified or contaminated—pure water—on reaching the surface will immediately collapse, and the formation of bubble or air froth is impossible; but air-bubbles in modified water will not instantly disappear on gaining the surface. The degree of their permanency after reaching the top largely depends on the degree of modification of the water.

There has been much expert evidence relating to the subject of surface tension to the effect that in the

case of pure water it is so great as to cause the instant collapse of bubbles of air rising to the surface; but that through modification of the water, the tension is so reduced in force as to permit the continued existence for a greater or less period of bubbles of air reaching the surface. The water in the ore pulp of the defendant's process is strongly modified and of necessity the bubbles on reaching the surface do not and cannot instantly disappear; but, on the contrary, in accordance with the operation of natural laws about which there is no conflict, persist and continue on the surface as a bubble or air froth. But whatever may be the true explanation of the phenomenon of the continuance and disappearance of escaping bubbles, the fact remains that the defendant's process discloses a froth consisting of bubbles which have passed through modified water to the surface of the mixture, and float thereon, and with their freight of metallic particles flow over the edge of the containing vessel into a launder, thus effectively separating the valuable mineral from the gangue particles. Coherency and permanency in a froth admit of degrees, and such a degree as insures by air flotation an efficient and final separation between the metal and the gangue, whatever may be the duration of the froth, comes within the process of the first patent in suit.

The defendant further insists that its process lacks violent agitation which it claims is an essential of the process of the first patent in suit. Each of the twelve claims of the patent mentions as an element of the process "agitating the mixture," but not one of them mentions violent agitation. It is, however, urged that as the descriptive portion of a patent for a process must contain a full and fair disclosure of the patented invention the claims must be read in the light of the description, and as violent agitation is included in the description the claims with respect to agitation

must be limited to violent agitation. But the description nowhere mentions "violent agitation" or uses any equivalent expression. It mentions "vigorous agitation," and states that in the case of the application of the patented process to an ore containing "feruginous blende, galena, and gangue consisting of quartz, rhodonite, and garnet," the mixture is "briskly agitated." It also describes as a part of the apparatus for carrying on the process a "rotatable stirrer." But I do not find in the description any specification of any rate of speed for the rotatable stirrer, or of any standard for the determination of what constitutes a "vigorous agitation" of the mixture, or a specification of any test for ascertaining whether the mixture is "briskly agitated." All these matters were left to the judgment and skill of the metallurgical engineer conducting or superintending the operation of the process, involving empirical investigation to reach the best results. The strength of agitation referred to in the description clearly admits of different degrees, varying from one another in the application of the process to different ores and under changing conditions. There is no room for doubt that agitation of the mixture in the process of the defendant is sufficiently vigorous or brisk to insure efficient ore concentration by an air flotation process such as is accomplished by the complainant by agitation under the process of the first patent in suit. This being true the use of mere adjectives in the descriptive portion of the patent with respect to agitation is unimportant. In order that the bubbles in the pulp mixture may come in contact with the metallic particles there must be such movement between them as cannot be wholly accounted for by selectivity as between them, and their movement so far as not accounted for by selectivity is the result of agitation; and whether such agitation results from the stirring or beating of the

mixture or the forcing or admission of air into it is immaterial; for what this court is dealing with is not an apparatus patent but a process patent.

Patent No. 1,104,755, of July 21, 1914, to John M. Callow, covers apparatus relating to ore concentration. The evidence shows that the defendant in its concentration of ore in its pneumatic flotation plant employs the process of patent No. 793,808, of July 4, 1905, to Sulman and Picard, hereinbefore discussed, as modified by the use of certain apparatus substantially the same as a portion of the apparatus, the operation of which is described in the above-mentioned Callow patent, as follows:

“From the foregoing, it will be understood that I employ no mechanical propellers for producing the necessary agitation and beating into the froth of large volumes of air, but that I depend upon the compressed air admitted through a porous body which has the function of splitting up the air into innumerable fine streams and distributing these fine streams over and into substantially the entire surface of the pulp, whereby immediately upon the introduction of the air, a more or less violent agitation or ebullition takes place and a froth begins to generate and to finally rise and form on the surface of the pulp.”

The character of the agitation above described is also clearly recognized in the claims of the Callow patent.

The combination of claim 1 of the first patent in suit contains the following elements: (1) Mixing powdered ore with water; (2) adding a small proportion of an oily liquid having a preferential affinity for metalliferous matter (amounting to a fraction of one per cent. on the ore); (3) agitating the mixture until the oil-coated mineral matter forms into a froth; and (4) separating the froth from the remainder by flotation. The elements in the combination of claim 12 are (1)

separating the mineral from gangue by coating the mineral with oil in water containing a fraction of one per cent. of oil on the ore; (2) agitating the mixture to cause the oil-coated mineral to form a froth; and (3) separating the froth from the remainder of the mixture. The elements entering into the defendant's infringing process are the same as those of claims 1 and 12 of the first patent in suit. There is no escape, I think, from the conclusion, not only that the defendant infringed the first patent in suit by carrying on the process of ore concentration in its first installation at Miami in apparatus in imitation of the plaintiff's standard machine, but also has infringed and is infringing the same patent by carrying on the process of ore concentration in its pneumatic flotation plant at the same place.

The second patent in suit, No. 962,678, of June 28, 1910, to Sulman, Greenway and Higgins, is for "Improvements in ore concentration." The patentees state that the object of the invention is "to separate certain constituents of an ore such as metallic sulfids from other constituents such as gangue when the ore is suspended in a liquid such as water." This patent is distinguishable from the first patent in suit; the object of the invention of that patent being, as stated, "to separate metalliferous matter, graphite, and the like from gangue by means of oils, fatty acids, or other substances which have a preferential affinity for metalliferous matter over gangue." It appears from the patent as a whole that "other substances which have a preferential affinity for metalliferous matter over gangue" are restricted to those of an oily nature. Such substances as mentioned in the various claims of the patent are "an oily liquid," "an oily substance," "oleic acid," "oleic soap solution" and "oil." No other frothing agent than the above substances enters into the process of the patent. The essence of the in-

vention of the first patent in suit was the restriction of the "oily substance" to "a fraction of one per cent. on the ore." In the process of the second patent in suit no oil, fatty acid, or oily substance is introduced into the mixture. The description contains the following statement:

"According to this invention the crushed ore is mixed with water containing in solution a small percentage of a mineral-frothing agent, (that is of one or more organic substances which enable metallic sulfids to float under conditions herein-after specified) and containing also a small percentage of a suitable acid such as sulfuric acid, and the mixture is thoroughly agitated; a gas is liberated in, generated in, or effectively introduced into the mixture and the ore particles come in contact with the gas and the result is that metallic sulfid particles float to the surface in the form of a froth or scum, and can thereafter be separated by any well-known means. Among the organic substances which in solution we have found suitable for use as mineral-frothing agents with certain ores are amyl acetate and other esters; phenol and its homologues; benzoic, valerianic and lactic acids; acetones and other ketones such as camphor. In some cases a mixture of two such mineral-frothing agents gives a better result than a single agent. * * * The present process differs from the two before mentioned types and from other known concentration processes by the introduction into the acidified ore pulp of a small quantity of a mineral-frothing agent, i. e., an organic compound in solution of the kind above referred to and by the fact that the metalliferous particles are brought to the surface in the form of a froth or scum not by mechanical means but by the attachment of air or other gas bubbles thereto. In the frothing processes hitherto known the substances used to secure the formation of a mineral-bearing froth has been oil or an oily liquid immiscible with water. According to this invention

the mineral-frothing agent consists of an organic compound contained in solution in the acidified water."

The charge of infringement has been restricted to claims 1, 2, 5 and 6, as follows:

"1. The hereindescribed process of concentrating ores which consists in mixing the powdered ore with water containing in solution a small quantity of a mineral-frothing agent, agitating the mixture to form froth and separating the froth.

2. The hereindescribed process of concentrating ores which consists in mixing the powdered ore with water containing in solution a small quantity of an organic mineral-frothing agent, agitating the mixture to form a froth and separating the froth.

5. The hereindescribed process of concentrating ores which consists in mixing the powdered ore with water containing in solution a small quantity of a mineral-frothing agent, agitating the mixture and beating air into it in a finely divided state so as to form a froth and separating the froth.

6. The hereindescribed process of concentrating ores which consists in mixing the powdered ore with water containing in solution a small quantity of an organic mineral-frothing agent, agitating the mixture and beating air into it in a finely divided state so as to form a froth and separating the froth."

It will be observed that no one of the claims of the second patent in suit requires as an element an oily substance or liquid, as is essential in the process of the first patent in suit, and all of the claims relied on require the introduction into the mixture of "a small quantity" of a "mineral frothing agent" or an "organic mineral frothing agent." The amount of the mineral frothing agent employed in the process is not confined to a fraction of one per cent. on the ore, but must be a small quantity, evidently to be determined

by the metallurgical engineer conducting or superintending the operation according to the requirements of the different ores. The novelty of this invention is to be found, not in any restriction of the amount of the mineral frothing agent to any stated proportion, for there is none, but in the fact that a mineral frothing agent as the means of separating the metallic particles from the gangue is substituted for the oil, fatty acid or other oily substance essential to the process of the first patent in suit. Such substitution has produced successful results, and, I think, involved invention. Frothing agents had theretofore been used in ore concentration, but not in the absence of an oily ingredient. Even were the grounds on which the validity of the patent can be sustained less clear, it should have the benefit of the presumption of validity arising from the grant of letters. That the defendant has infringed the claims in suit of the second patent is established by the evidence.

The third patent in suit, No. 1,099,699, of June 9, 1914, to H. H. Greenway, assignor to plaintiff, is for "Improvements in the concentration of ores." In the description it is stated:

"This invention relates to the concentration of ores and has been applied in practice to the concentration of copper ores the object being to separate certain constituents of the ore such as copper sulfids (for example in the form of copper pyrites) or metallic copper (natural or reduced) from other constituents such as gangue when the ore is suspended in a liquid such as water. The present process is a modification of the invention described in U. S. patent to H. L. Sulman, A. H. Higgins and myself, No. 962,678, granted June 28, 1910. The process therein described is applicable generally to the recovery of metallic sulfids and like floatable metalliferous matter and in the case of lead and zinc sulfids to which the process has been largely applied it is necessary for efficient

working that the pulp should be slightly acidified, and in most cases in practice the pulp is heated. It is now found that with copper ore such as an ore containing copper pyrites effective separation is obtained in the cold without the use of acid by employing as mineral frothing agents, aromatic hydroxy compounds such as phenol, cresol, or mixtures containing the same. The process of concentrating ores containing copper sulfid or metallic copper according to this invention consists in mixing the powdered ore with water containing in solution a minute quantity of aromatic hydroxy compound such as phenol or cresol but without mineral acid and in the cold, agitating the mixture to form a froth and separating the froth."

The first twelve claims of the patent are in suit, but it is unnecessary to set them forth in full. I do not find any element of patentability in the process of this patent. It is stated in the description that the process can be carried on "without mineral acid and in the cold," and "is carried out in the cold and no acid is added to the pulp." Under the second patent in suit the use of heat is optional, and no patentability can be attributed to the process of the third patent in suit on the ground that the process is carried on in the cold or without heat; for patentability can never result from the mere omission to do something, the doing or not doing of which is optional. There is a question on which a difference of opinion has been expressed, whether in the process of the second patent in suit the use of acid is also optional. The description in the patent considered alone requires the use of acid; but while five of the nine claims mention "acidified water," the remaining four do not refer to acid. It is not altogether clear to me under these circumstances whether the use of acid is not optional. But however that may be, I think that, in view of the processes of the prior art an omission to use acid in the process of the third patent in suit cannot confer patentability upon it.

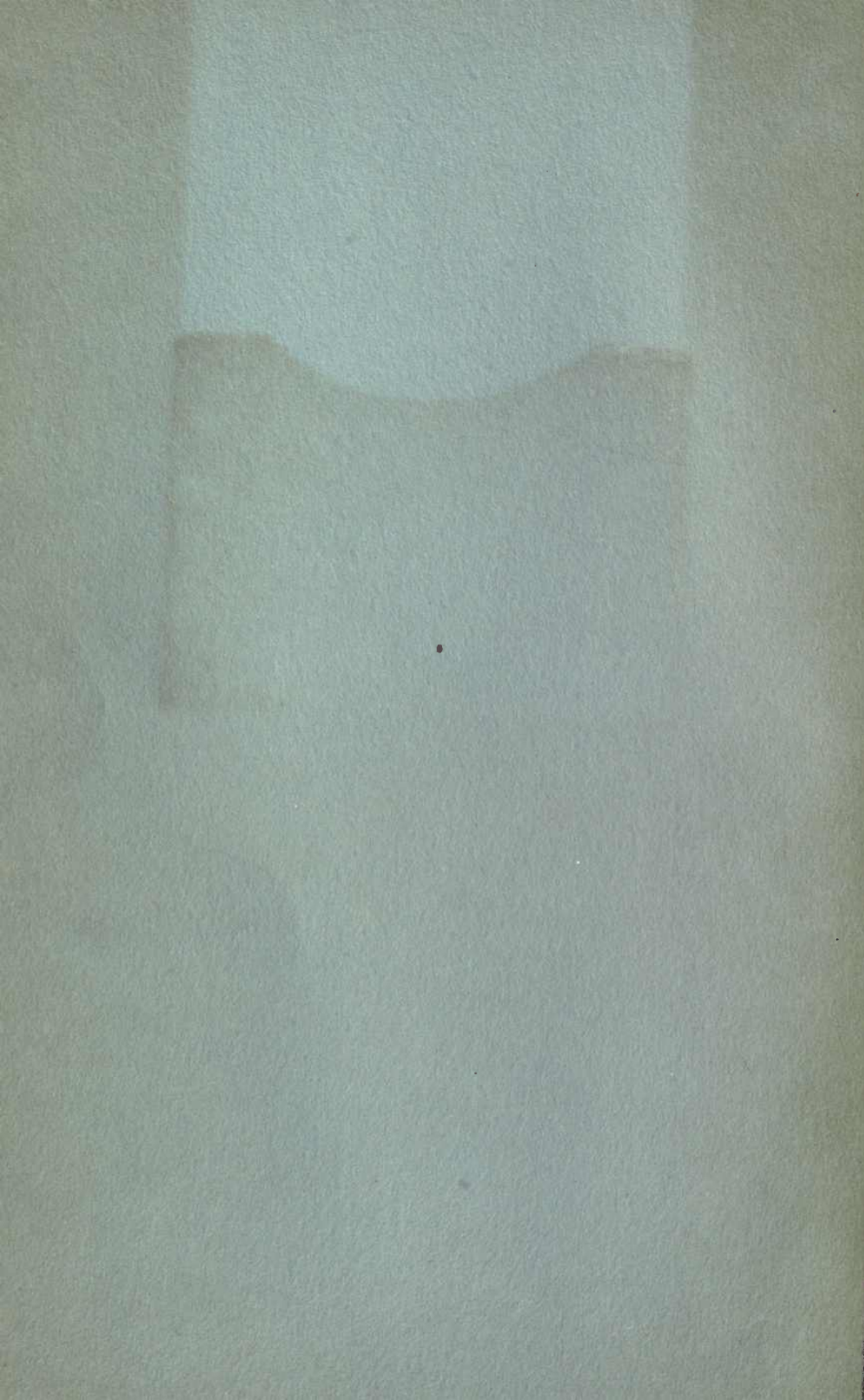
Many actual or supposed inconsistencies or contradictions in the testimony have been commented on by counsel, but, while they have been considered, I do not deem it necessary to a proper decision of this case that they should be discussed in this opinion.

A decree in accordance with this opinion may be prepared and submitted.

(Sgd.) EDWARD G. BRADFORD, J.

September 29, 1916.

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